MULTIYEAR DYNAMICS OF NITROGEN MINERAL FORMS IN AMUR WATER NEAR KHABAROVSK

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Nitrogen is one of the most important biogenic elements and its content determines biological productivity of water objects. The first data on ammonia nitrogen in Amur water (up to 2% of total content) were obtained by pharmacist Bobritsky in 1895. On the contrary observations of sanitary doctors of the Khabarovsk hospital in 1909-1912 registered only trace concentrations of nitrogen compounds in Amur water [2, 6].

P.C. Zhdanov's studies in 1946-1955 also proved low concentrations of nitrogen mineral forms in water [1]. Before 1953 the presence of ammonia nitrogen in Amur water had been identified only with qualitative reactions and after 1953 it fluctuated within 0.07-0.19 mgN/dm^3. The registered highest concentrations were 0.41mgN/dm^3. Nitrates were found in water only in some months.

Roshydromet has started regular observations of nitrogen mineral forms in the middle of the Amur River at Khabarovsk since 1975. Observation data reveal increased nitrogen concentrations in winter [4]. For the 1975-1988 period winter multiyear average concentration of ammonia nitrogen was 0.84 0.41 mgN/dm^3, and that of nitrate nitrogen was 0.20 0.41 mgN/dm^3, which corresponded to the discharge of 70.7 and 21 tons/day respectively. The ammonia form of nitrogen prevailed in nitrogen discharge all those years excluding 1982 and 1986.

In non-freezing period ammonia and nitrate nitrogen content is lower. In the 1976-1980 period average concentrations were 0.62 and 0.02 mgN/dm^3 respectively and discharge due to high water content was 554.8 and 17.8 tons/day respectively. Total average water discharge of ammonia and nitrate nitrogen per year was 143.9 and 6.9 thousand tons.

Our studies in 1996-2009 at 3-5 stations equally distant across the river proved a bigger amplitude of concentration fluctuations of ammonia (0.06-2.15 mgN/dm^3) and nitrate (from 0.01 up to 0.71 mgN/dm^3) nitrogen.

In winter low water multiyear average concentrations of ammonia and nitrate nitrogen is 0.65 and 0.37 mgN/dm^3 respectively. The lowest concentrations of ammonia nitrogen was registered in winter low water in 1999 after catastrophic floods in the Sungari River basin in summer 1998 and in 2008-2009 after the significant increase of regulated Bureya River share in the Middle Amur runoff (Fig. 1).

Opposite dynamics of nitrate nitrogen content was observed in winter low water in 1998-1999, 2001-2003, 2006-2007 and 2008-2009, when nitrate nitrogen concentrations exceeded 0.43mgN/dm^3. Maximal ammonia nitrogen concentrations were registered in March 2000 (2.15 mgN/dm^3), and maximal nitrate nitrogen concentrations were registered in December 2005 (0.69 mgN/dm^3). Average daily discharge of ammonia nitrogen in the Amur water in 1996-2007 was 111.4 tons and that of nitrate nitrogen – 59.1 tons, i.e. compared to

1975-1988 it increased 1.6 and 2.8 time respectively. Maximal for the observation period discharge of ammonia nitrogen was registered in February 2000 (260 tons/day) and that of nitrate nitrogen – in December 2005 (176 tons/day). It happened after the accident at the chemical plant in the City of Jiling (China). Minimum discharge of ammonia and nitrogen nitrate (Fig.2) was observed in low water content winters (2001-2003, 2004-2005 and 2008-2009).

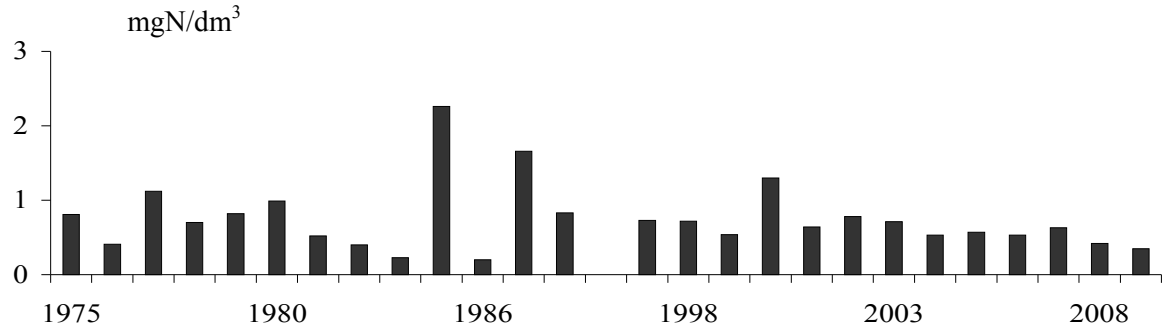

Fig.1. Multiyear Dynamics of Ammonia Nitrogen in the Amur River at Khabarovsk in Winter Low Water in 1975-1988 and 1996-2009

Nitrite nitrogen concentrations in Amur water was within the range 0.03-2.71 tons/day and was 1.06 tons per day as average. The lowest concentration was registered in 2005 and the highest concentration was registered in 2006 after the accident at the chemical plant in the City of Jiling (China).

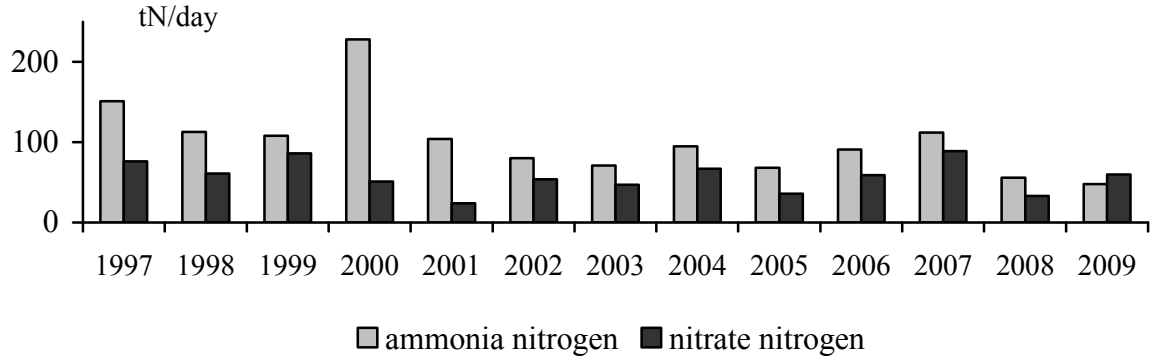

Fig. 2. Multiyear Dynamics of Ammonia and Nitrate Nitrogen in the Amur River at Khabarovsk in Winter Low Water 1997-2009.

In time of floods nitrate nitrogen content prevails over the content of ammonia nitrogen in Amur water chemical composition. In May 2006 maximal concentration of nitrate nitrogen was 0.37 mgN/dm^3 and ammonia nitrogen concentration was 0.22mgN/dm^3. Nitrite nitrogen concentration was much lower (up to 0.009mgN/dm^3). Similar concentrations of these elements were observed in May 2009. The highest concentration on nitrate nitrogen at that time was 0.47 mgN/dm^3 and that of ammonia nitrogen – 0.60 mgN/dm^3. Nitrite nitrogen

concentration was lower 0.007 mgN/dm^3.

In summer low water nitrogen mineral form concentrations were much lower due to phytoplankton consumption. In July 1997 nitrate nitrogen concentration in the middle and at the left bank of the Amur River did not exceed 0.01 mgN/dm^3 and that of ammonia nitrogen – 0.13 mgN/dm^3. A much higher concentration of ammonia nitrogen (up to 0.41 mgN/dm^3) and similar to this that of nitrate nitrogen were observed in June 2006, when water level was 87 cm. Nitrite nitrogen content at that time was lower 0.002 мгN/дм^3.

During floods formed in the Sungari basin nitrate nitrogen content in water reaches its maximum and prevails over ammonia nitrogen. In July 1998 nitrate nitrogen content was 0.56 mgN/dm and its discharge was 813 tons/day. Much higher concentrations and discharge were observed in August 1998. Nitrate nitrogen content during the flood did no exceed 0.68 mgN/dm^3 and at the flood peak reached 1.0 mgN/dm^3. Even during the flood decline at the end of October its concentration exceeded 0.27mgN/dm^3. Maximal discharge of nitrate nitrogen at that time was 2145 tons/day. Nitrate nitrogen concentration was increased during the floods in 2002 (0.92 mgN/dm^3) and in 2005 (0.64 mgN/dm^3). The similar situation happened in 2009, when maximal nitrate nitrogen concentrations reached 0.50 mgN/dm^3 and the maximal nitrate nitrogen discharge was 1339 tons per day, which 3-times exceeded the annual amount of nitrate nitrogen, discharged by the Russian industrial enterprises. Keeping in mind the duration of the flood (88 days), when water level was over 2.5 meters (Fig.3), we may speak of a noticeable discharge of nitrate nitrogen in the period from July 3 to September 29 (approximately 60 thousand tons).

Such increase of discharge of nitrogen mineral forms is an evidence of accelerated economic activity in the Middle Amur area. Hydrochemical studies in the boundary Amur passages revealed that most amount of nitrogen compounds come into the Amur with Sungari water, i.e. from China. In March 2000 near Nizhneleninskoe village in the waterway lower the Sungari juncture ammonia ion concentration was 2.4 mgN/dm^3. In the Russian part of the river ammonia ion concentration was 4-5 times lower [6]. The similar situation was observed in this Amur passage in December 2005, when ammonia and nitrate nitrogen concentrations in the Chinese part was 1.4 and 1.91 mgN/dm^3 and in the Russian part of the river they were 0.23 and 0.25 мгN/дм^3 respectively. In the non-freezing period nitrate nitrogen concentrations significantly differ and in the Chinese part of the Amur they are 54 times higher than in the Russian part.

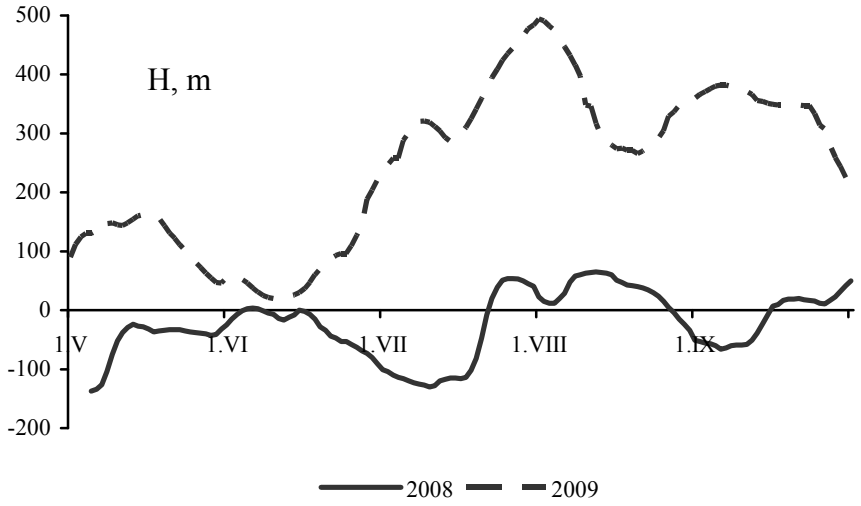

Fig. 3. Water Level Fluctuations in the Amur River at Khabarovsk in April-September 2008-2009

The undertaken studies proved significant increase of concentrations and discharge of nitrogen mineral forms in Amur water during many years due to acceleration of economic activities in the Upper and Middle Amur basins, mostly on the Chinese territory. In winter low water in the 1996-2009 period ammonia and nitrate nitrogen discharge increased 1.6 and 2.8 times respectively compared to the 1975-1988 period. Noticeable amount of nitrogen compounds comes into the Amur in time of floods, formed in the Sungari Basin.

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